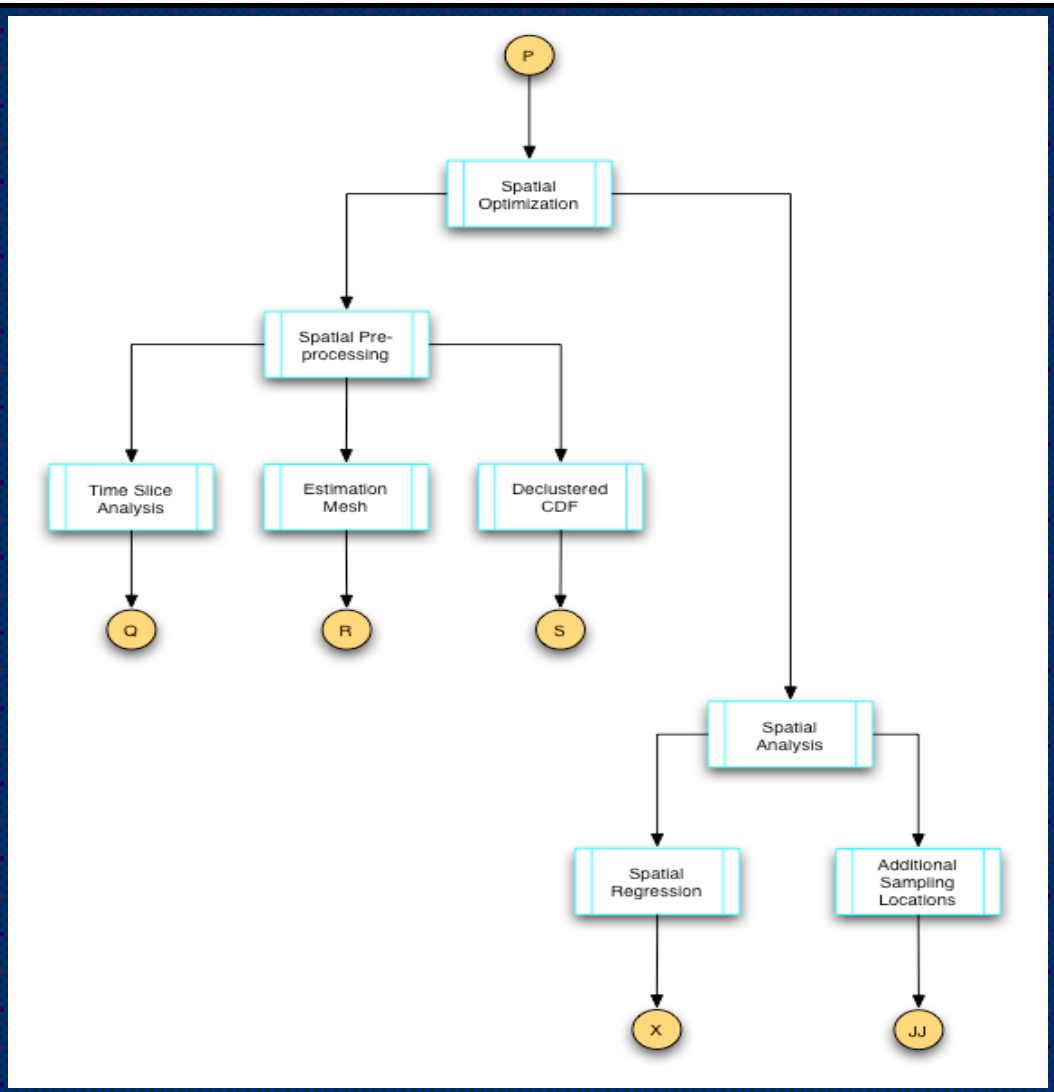
Spatial Analysis



Spatial Underpinnings

- All about maps
  - Degree of redundancy depends on map deterioration
  - Vital to build good base maps
    - By COC, aquifer horizon, time slice
  - Compare maps made at each level of data removal
    - Want fast, accurate estimation technique
    - Deterioration measured both visually, numerically
      - Concentration difference maps (bias maps)
      - Cost-accuracy tradeoff curves

Spatial Pre-Processing

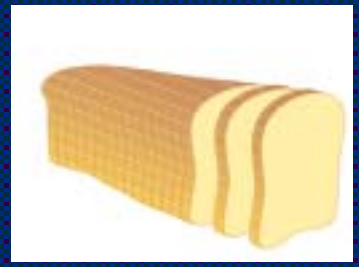
- Key steps
  - Outlier screening
  - Time slices
  - Building CDF, indicator data
  - Estimation Mesh

Outlier Screening

- Often have spurious ‘spikes’ in concentration
  - Examine time series plots well-by-well
  - Remove obvious outliers from most recent data

Create Time Slices

- Goal: series of snapshots of plume/site
  - Assess redundancy for each slice
- Nuts & bolts
  - GTS automates time slice selection
    - Begins with most recent data
    - Ensures sufficient fraction of wells sampled during each slice
    - Maximum of 5 slices selected
- Helps account for seasonality



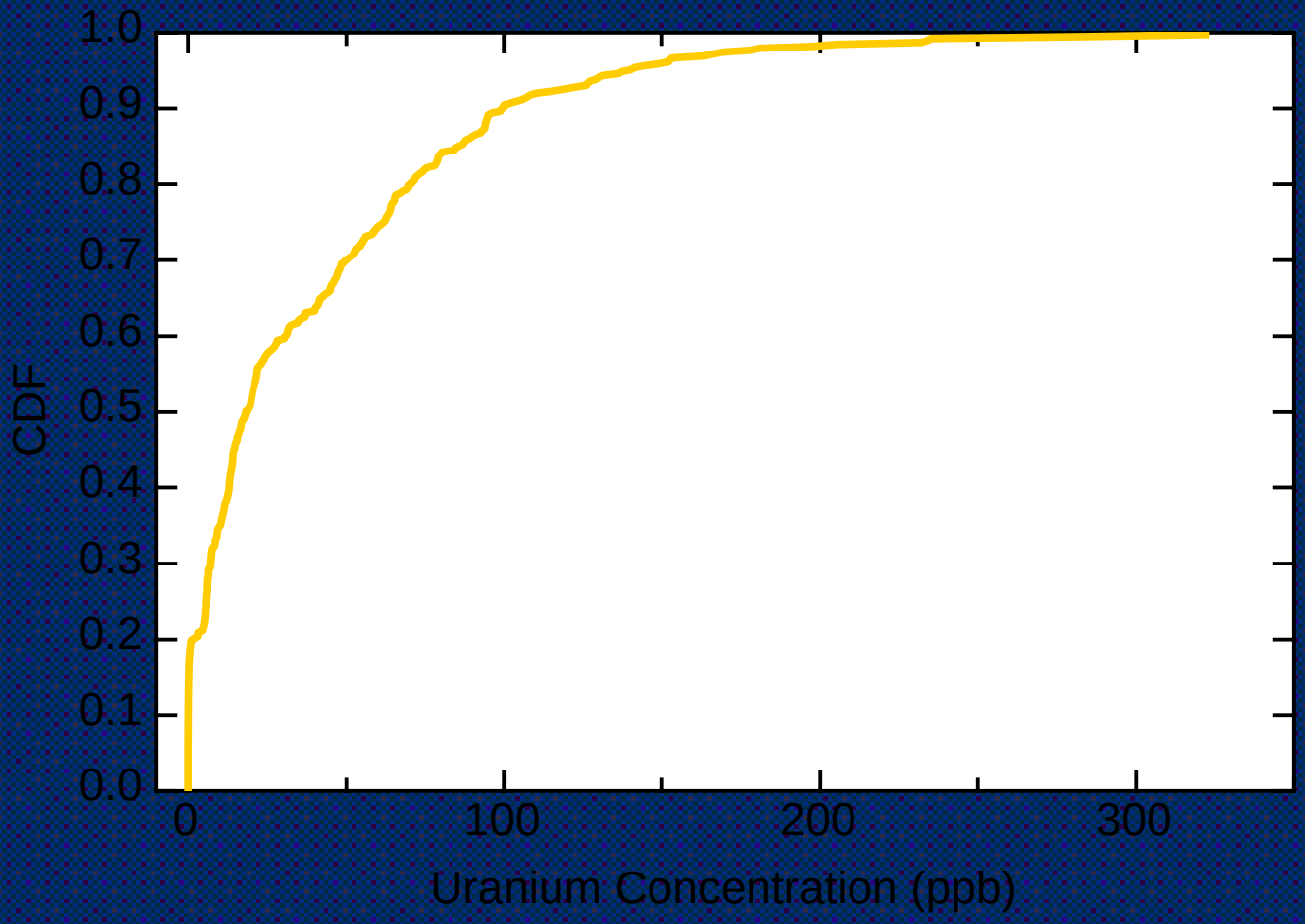
Uranium Time Slices

Slice	N wells	Intensity	Date Range (wks)
1	29	0.76	315 - 335
2	29	0.76	263 - 315
3	33	0.87	191 - 263
4	32	0.84	87 - 191

Univariate CDF, Indicator Data

- Multiple Indicator Local Regression (MILR) is quasi-nonparametric
  - Relies on statistical distribution (CDF) of observed measurements
    - Typically quite skewed, non-normal
    - GTS compiles CDF across time slices to better capture variation over time
- CDF used to pick indicator cutoff levels
  - Values close to fixed percentiles
  - Indicator 0-1 data created for each cutoff

Uranium CDF


1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
CDF
0
100
200
300
Uranium Concentration (ppb)

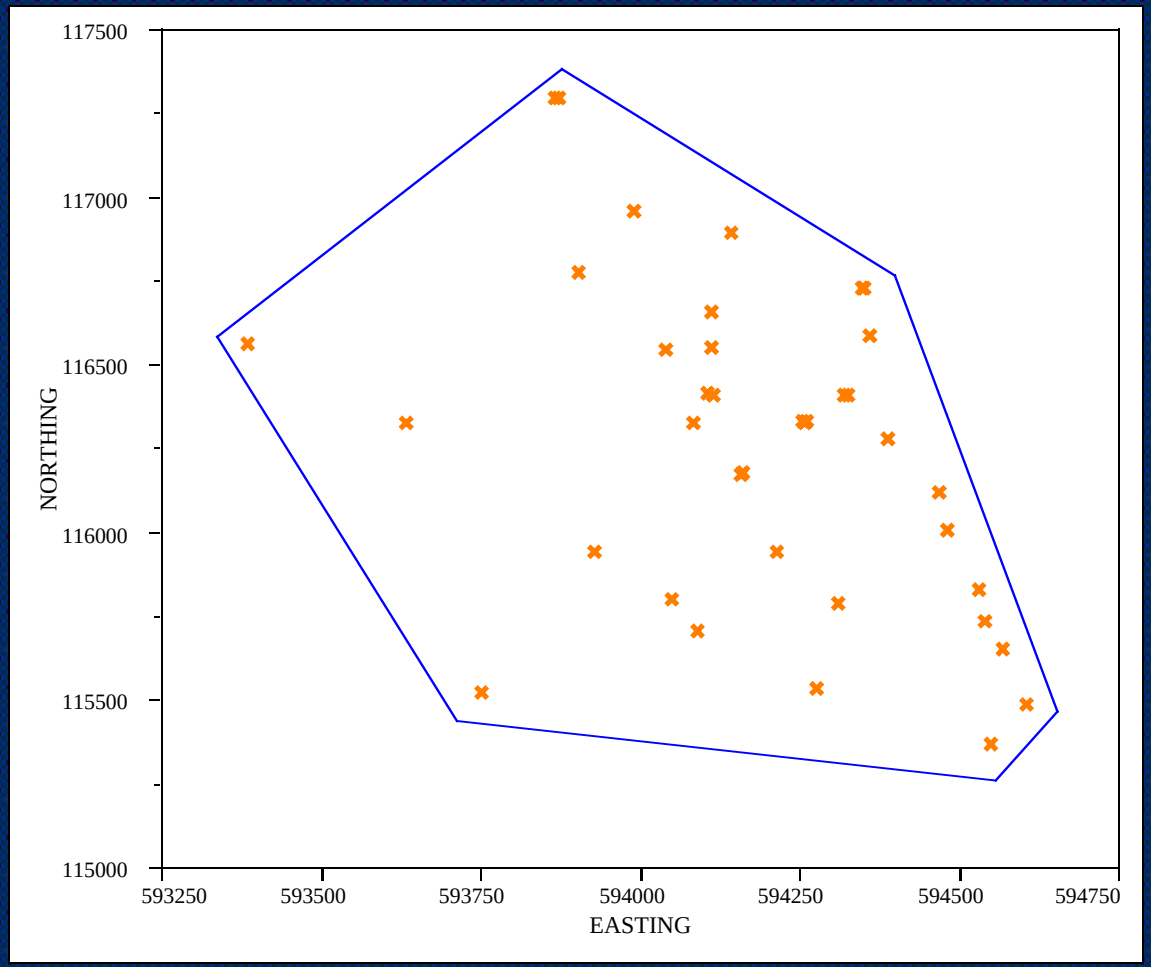
Uranium Cutoff Levels

NUM	CUTOFF	RAWCUT	PCT
1	0.1	0.082	0.1
2	3	3.16	0.205
3	7	7.16	0.306
4	15	13	0.406
5	20	19.7	0.507
6	30	31.8	0.607
7	50	52.5	0.707
8	70	71.6	0.805
9	100	100	0.903
10	150	141	0.952
11	250	235	0.991

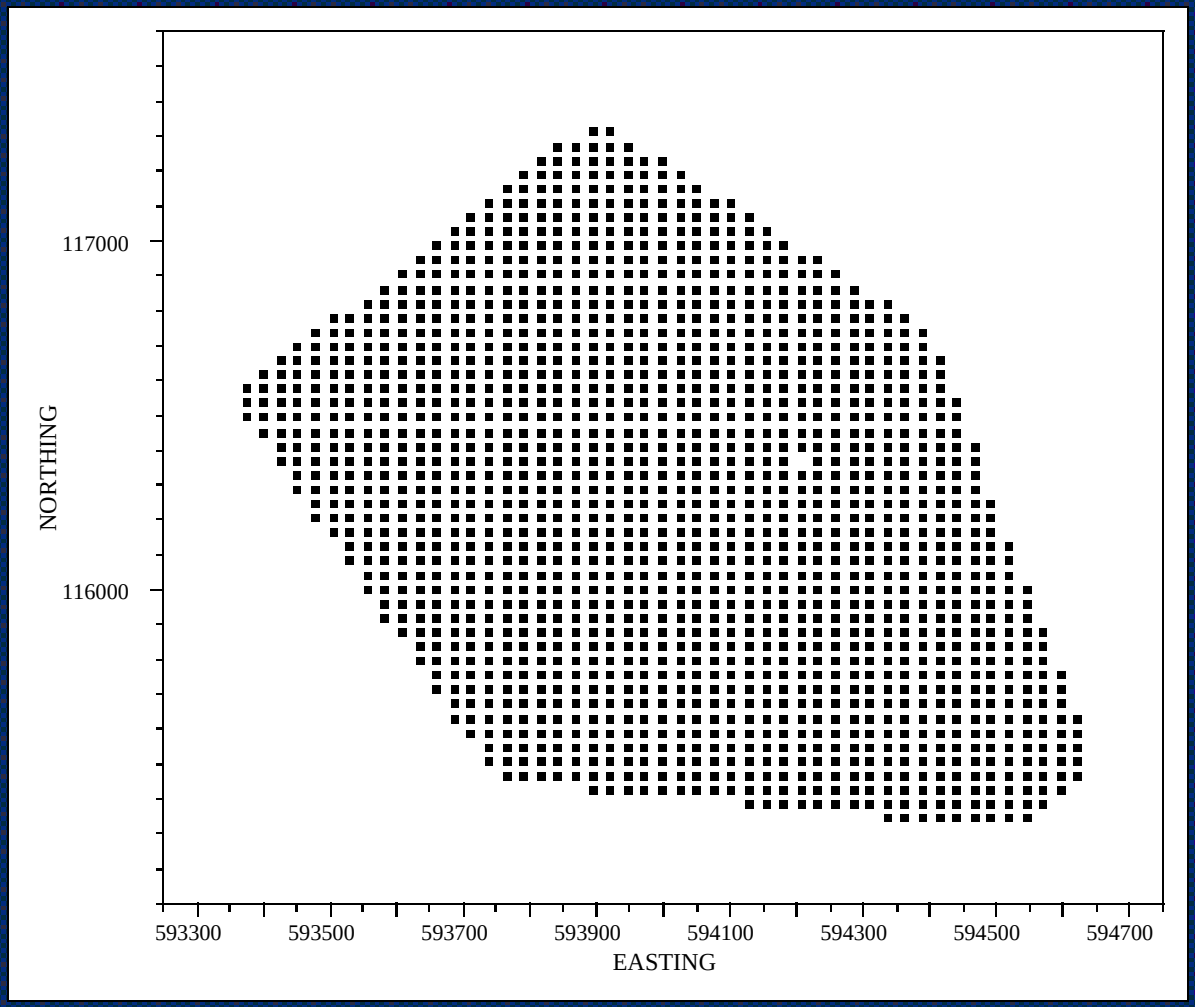
Estimation Mesh

- Grid of pts where local regression estimates made
- Key: balance processing time, grid density
  - GTS computes dense grid while estimating surface elevation
  - Estimate of time needed for minimal grid
    - User can increase time allotted

Uranium Site Map



Uranium Site Mesh



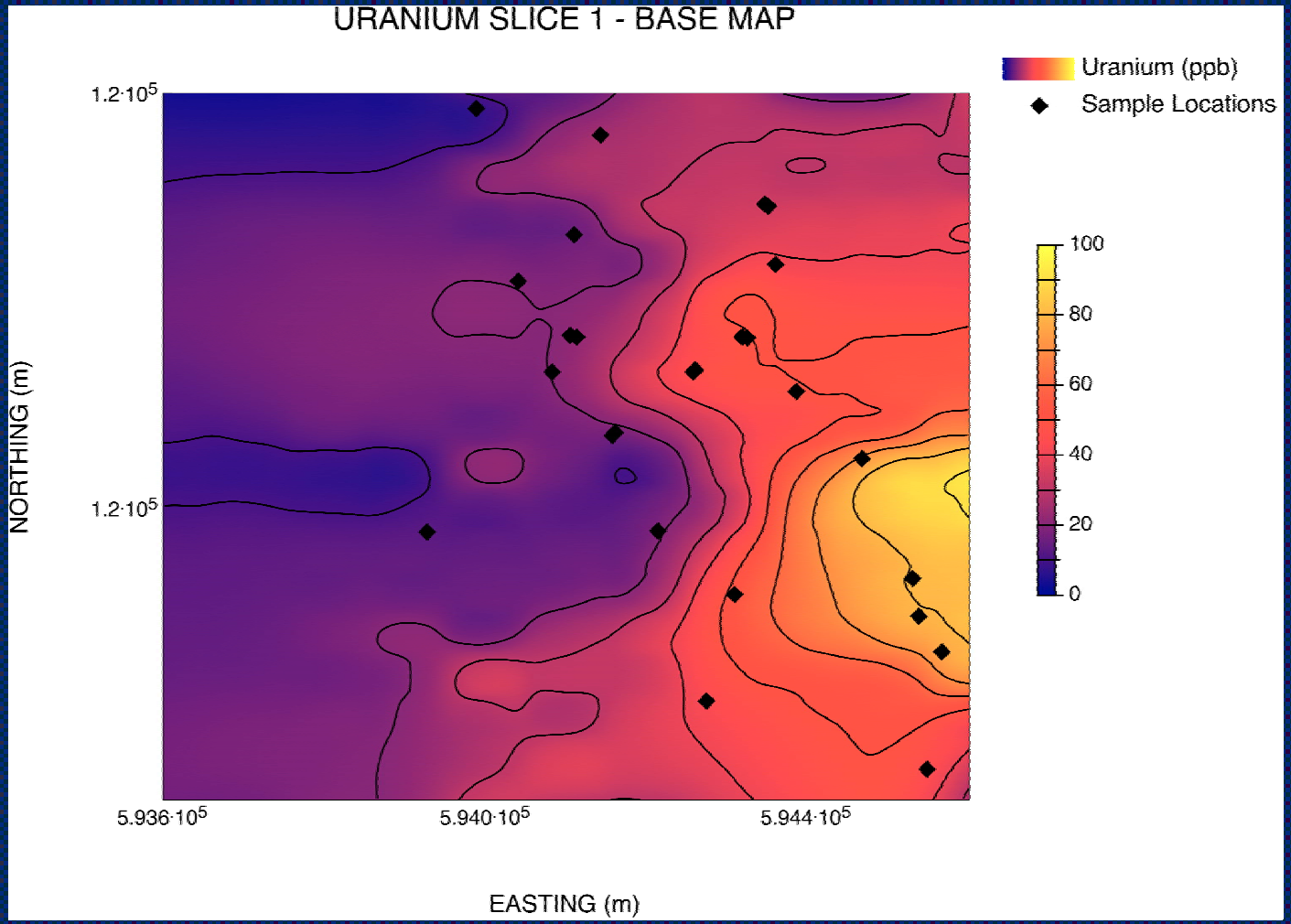
Begin Optimization

- Key steps:
  - Create base maps
    - Pick spatial bandwidth
  - Iteratively remove well locations
    - Kick out locations with greatest redundancy
    - Re-estimate maps periodically
  - Build cost-accuracy tradeoff curves
    - Determine level of optimal removal
  - Construct optimal (reduced) network

Creating Base Maps

- MILR first uses all available data
- Must pick spatial bandwidth for each slice
  - Compute residuals at each known location
    - Check range of possible bandwidths
    - Residual post plots
    - CP criterion, goodness-of-fit measures
  - Use same bandwidth choices for redundancy analysis

Uranium Slice 1 Base Map



Check Base Map Accuracy